# The Express Highway through the city of St. Louis

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# THE EXPRESS HIGHWAY
# THROUGH THE CITY OF ST. LOUIS

BY

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A

THESIS

Submitted to the faculty of the

SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI

In partial fulfillment of the work required for the

Degree of

CIVIL ENGINEER

Rolla, Mo.

1937

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Professor of Civil Engineering

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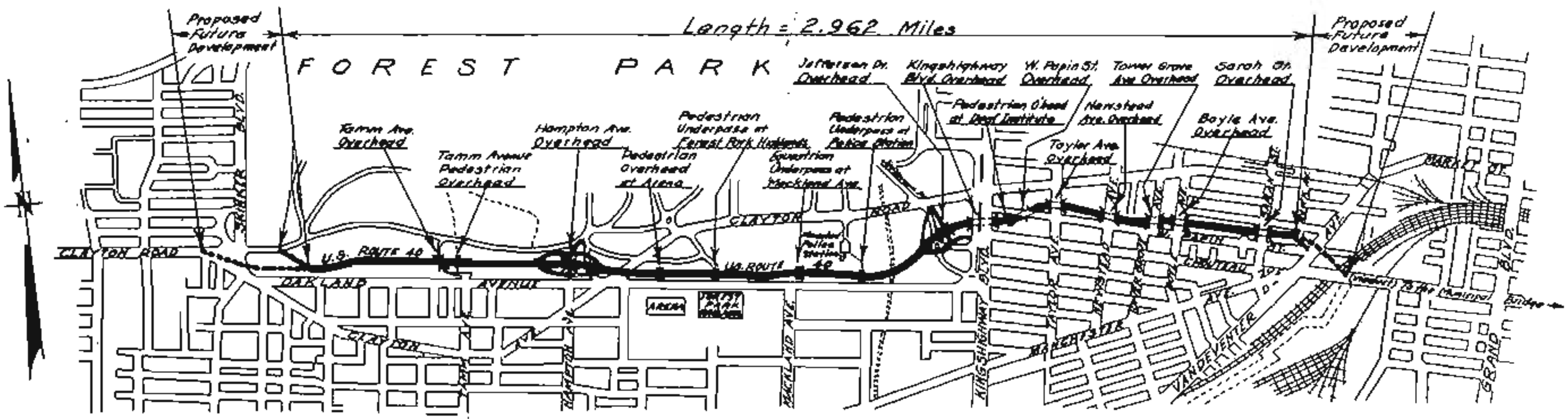


Map showing location of the Express Highway through the City of St. Louis

## INTRODUCTION

Among the many important highway construction projects undertaken in Missouri, the Express Highway through the City of St. Louis ranks among the first both because of the cost and difficulties involved, and because of the improvement in traffic conditions which it provided. This highway enters the city at the southwest corner of Forest Park, which is the junction of Skinker Road and Oakland Avenue. The accompanying map will give an idea of the location of the highway from this point to its end, a distance of approximately two and ninety-six one hundredths miles. The most noteworthy feature is that there are no grade crossings and traffic is permitted to enter and leave the Express Highway only at the "clover-leaf" intersections at Hampton Avenue and Jefferson Drive. There have been several unusual features incorporated in the design of this project; such as pedestrian overhead structures at Tamm Avenue, opposite the Arena, and opposite the Central Deaf Institute. Two pedestrian underpasses have been provided, one opposite Forest Park Highlands, which is an amusement company, and the other opposite the Forest Park Mounted Police Station; an equestrian underpass has been provided at Mackland

Avenue to permit all horses with riders to pass under the highway. The writer supervised the inspection of the materials and much of the actual construction of the structures, the pavement, and the retaining walls.

FIGURE 1 - TAMM AVENUE OVERHEAD

Entering the park from the southwest the first structure is an overhead at Tamm Avenue. This is a 66-foot steel rigid frame structure on a 24°-38′ curve with a 32-foot roadway and two 5-foot sidewalks. These sidewalks are 12 inches above the roadway and are protected with a structural steel handrail. The concrete in the deck was proportioned and placed to develop special high strength. The proportioning was 1:1.7:3 by weight, with a total effective moisture not to exceed 6 gallons of water per sack of cement. Good compaction was secured through the use of mall vibrators.

The entire fill face of abutments and retaining walls were treated with a heavy bituminous waterproof coating. All construction joints were given special attention by applying a strip of cotton fabric which extended 6 inches each side of the joint and was pressed into place in the hot asphalt.

FIGURE 2 - TAMM AVENUE PEDESTRIAN OVERHEAD

This structure is a continuous plate girder of three spans; one 34 foot, one 58 foot, and one 66 foot with a 6 inch concrete deck, 8 feet in width. The entire structure is covered with a sheet steel roof, electrically welded to waterproof the joints, supported on 6 inch H columns. Chain link mesh completely encloses the opening from the top of the steel handrail to the roof. The slab of this structure is of the same high strength concrete as the Tamm Avenue overhead.

FIGURE 3 - HAMPTON AVE. OVERHEAD

The structure at Hampton Avenue is an overhead consisting of two 37 foot spans and one 81 foot span. These spans are of steel girders on concrete bents. There is a 50 foot roadway with two 6 foot sidewalks. The sidewalks, like the Tamm Avenue structure, are 12 inches above the roadway and are protected by a structural steel handrail. The deck is of special high strength concrete. All fill faces were treated with waterproof coating.

FIGURE 4 - THE ARENA PEDESTRIAN OVERHEAD

Opposite the Arena a pedestrian overhead was constructed consisting of one 43 foot and one 54 foot steel girder span on concrete bents. The deck is 12 feet wide and 6 inches thick, with a roof similar to the Tamm Avenue pedestrian crossing. This deck is of high strength concrete. The south end of the span is supported by a tower with reinforced concrete stairs leading to the street level from both sides of the tower and at right angles to the span. The sides are enclosed with chain link mesh.

FIGURE 5 - FOREST PARK HIGHLANDS UNDERPASS

The crossing opposite Forest Park Highlands is a pedestrian underpass. The barrel of the underpass is 53 feet long and 12 feet wide. The stairs leading to the surface are at right angles to the barrel. The over-all length of the stair system on the south along Oakland Avenue is 154 feet, including a 28 foot splash wall at each end of the stairs. Between the two entrance houses there is a 48 foot street car loading platform covered with a concrete canopy and enclosed on the highway side with a steel grill wall. This wall affords street car passengers protection in inclement weather while waiting for cars. The over-all length of the north stair system is 123 feet. The difference in length of the two stair systems was caused by the presence of a 50 inch water-main paralleling Oakland Avenue and a few feet to the north. It was necessary to carry the underpass beneath this main. This task was accomplished by constructing the barrel at two levels and connecting them with stairs. The water-main is supported in a block of concrete cast around the pipe and poured with the roof slab. The thickness of the walls under the main was increased and more steel was added. At each of the four street level entrances there is a shelter house. Each of these houses contains four windows on each side, protected by heavy wire screens. The walls of the structure are lined with white glazed tile and the ceilings painted with two coats of white Portland Cement paint. All fill surfaces were treated with three moppings of bituminous waterproofing and two layers of treated cotton fabric.

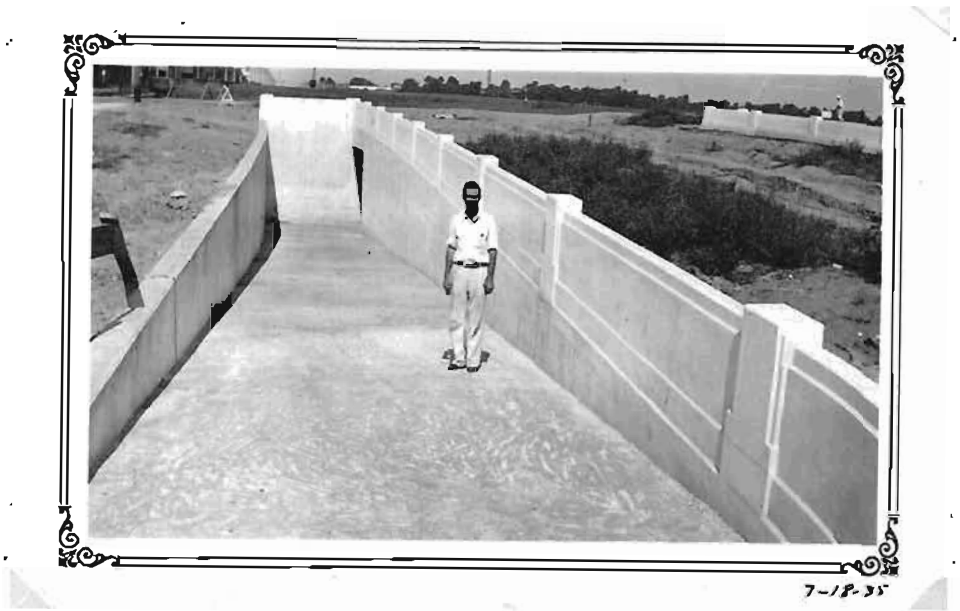


FIGURE 6 - MACKLAND AVENUE EQUESTRIAN UNDERPASS

There are several stables along Mackland Avenue that make a practice of renting saddle horses. In order to provide a means of entrance into the park for this class of traffic an equestrian underpass was constructed. This structure consists of a barrel 53 feet long and 12 feet wide with an open ramp at each end of the barrel. The barrel and the ramps are on an 8% grade. The ramp slabs consist of a 5 inch concrete base course and a 1 inch asphaltic concrete wearing surface. All fill faces received the same waterproofing as the structure opposite the Forest Park Highlands.

FIGURE 7 - PEDESTRIAN UNDERPASS
AT MOUNTED POLICE STATION

The structure at the mounted police station is a pedestrian underpass. The length of the barrel is 59 feet and the width is 8 feet, 2 inches. The over-all length of the stair system on the south end is 54 feet, 4 inches; and 61 feet at the north end. The barrel of this underpass is also below the water main. Unlike the structure at the Highlands, there is only one stair entrance at each end of the barrel. There is a house constructed to protect each entrance. The inside walls are tiled and the ceiling painted with white Portland Cement paint. All fill surfaces are waterproofed similar to the other underpasses.

FIGURE 8 - JEFFERSON DRIVE OVERHEAD

At Jefferson Drive a 56 foot steel rigid frame bridge with concrete counterfort v-abutments was constructed. Special high strength concrete was used to construct the roadway, sidewalks, and curbs of the super-structure. The roadway is 32 feet in width, with two 5 foot concrete sidewalks on each side. Ramps to carry traffic from park drives to the Express Highway were constructed at this intersection.

FIGURE 9 - KINGSHIGHWAY OVERHEAD

The Kingshighway overhead, a 54 foot concrete rigid frame span with cantilever abutments, was constructed with special high strength concrete with the exception of the bridge railings. The bridge, 134 feet, 6 inches in width, carries two motor traffic drives and double electric railway tracks over the Express Highway. One motor traffic drive, on the west side, is a 40 foot concrete slab with a 10 foot penetration macadam widening. The east side is a 26 foot asphaltic concrete surface with a 5 foot concrete widening on both sides. All fill faces of the structure were treated with two moppings of bituminous waterproofing and two layers of treated cotton fabric.

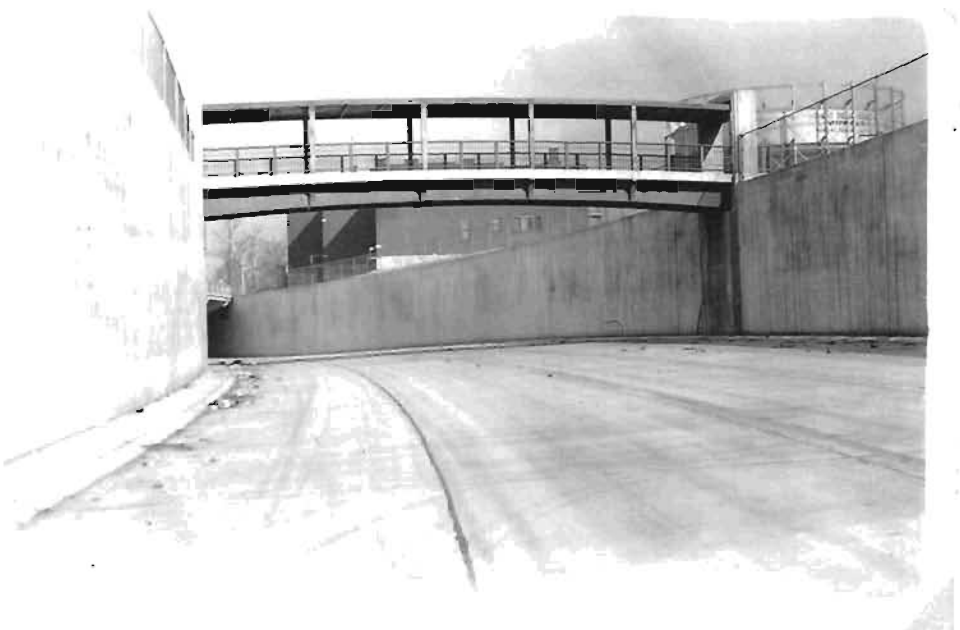

FIGURE 10 - CENTRAL DEAF INSTITUTE

PEDESTRIAN OVERHEAD

This structure was constructed to connect the deaf institution with a play ground that will be provided for the deaf children. It is similar in construction to the other pedestrian overheads in that the floor rests on steel plate girders which are supported by concrete abutments. A 7 foot, 10 inch walkway is provided and it is completely covered with a plated steel top and enclosed with woven wire mesh.

FIGURE 11 - WEST PAPIN STREET OVERHEAD

At West Papin Street an overhead of one 125 foot steel truss on concrete abutments was constructed. The structure is on a 61° 27′ skew, which made construction quite complicated. There is a 36 foot roadway with two 8½ foot sidewalks. The deck is of special high strength concrete. Mix proportions of 1: 1.9: 3.4 were used. All fill surfaces of the abutments and retaining walls were damp proofed.

FIGURE 12 - TAYLOR AVENUE OVERHEAD

The Taylor Avenue overhead is a 56 foot rigid concrete span constructed of special high strength concrete. The bridge has a 36 foot roadway and two 6 foot sidewalks, one on each side. All fill faces of this structure were treated with three moppings of bituminous waterproofing and two layers of treated cotton fabric.

FIGURE 13 - NEWSTEAD AVENUE OVERHEAD

The Newstead Avenue overhead is a 156 foot rigid concrete span, carrying a 36 foot roadway with two 6 foot sidewalks. The waterproofing is the same as the Taylor Avenue overhead. Special high strength concrete was used throughout its construction.


FIGURE 14 - TOWER GROVE AVENUE OVERHEAD

The Tower Grove Avenue overhead is a 63 foot rigid concrete structure carrying a 36 foot roadway with two 6 foot sidewalks. The same method of water-proofing was applied to this structure as that of the Taylor Avenue overhead. The special high strength concrete was used throughout the construction.

FIGURE 15 - BOYLE AVENUE OVERHEAD

This overhead is a 55 foot rigid concrete structure carrying a 36 foot roadway with two 6 foot sidewalks. The same method of waterproofing was applied as on the Taylor Avenue project. All concrete was of the special high strength.

FIGURE 16 - SARAH STREET OVERHEAD

The Sarah Street overhead is a 55 foot rigid concrete structure with a 36 foot roadway, carrying double electric railway tracks. There are also two 6 foot sidewalks, one on each side. The waterproofing on this structure required 3 moppings of bituminous waterproofing and the two layers of treated cotton fabric. The special high strength concrete was used throughout the construction.

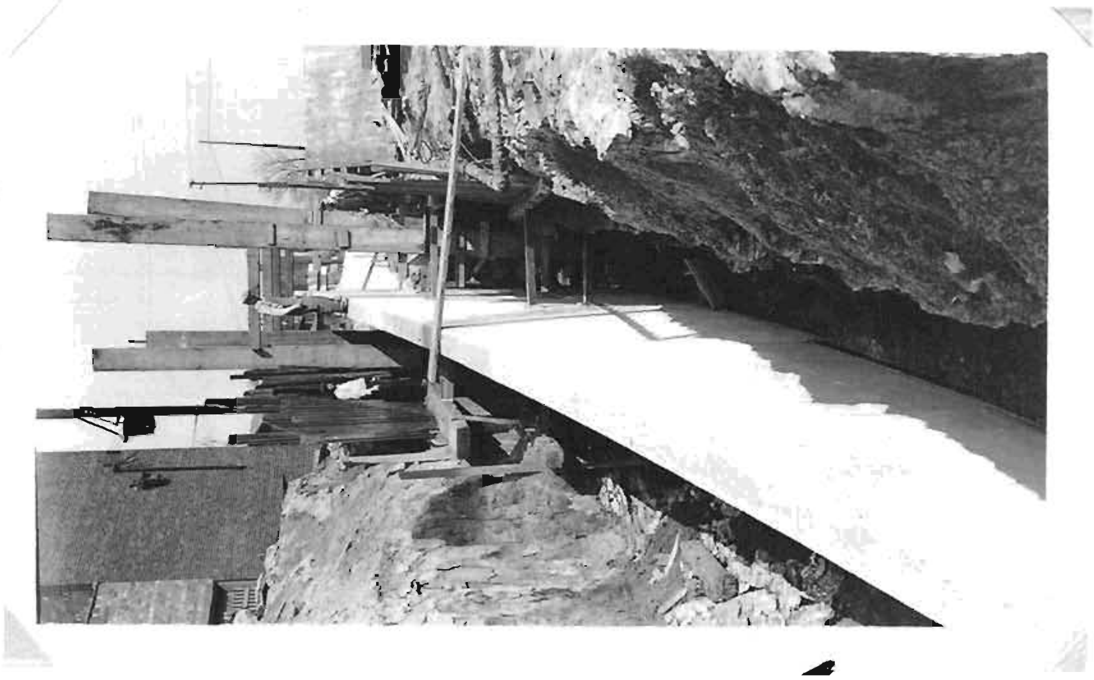

FIGURE 17 - THE RETAINING WALLS

The retaining walls were a very interesting part of the construction of the project. The erection of the walls before removing the excavation from the roadway enabled the contractor to save considerable on the forming. As is shown by the picture, there was very little lumber used in the forming of these walls. It was necessary to drive steel sheeting in many parts in order to hold the embankments. A two foot porous backfill was placed between the walls and the backslope. Difficulty was encountered in finding a solid base for the footings. Large cracks, running both horizontally and vertically, existed throughout most of the rock. It was necessary to grout these cracks under pressure, which caused much delay in the progress.

There were 1,914 cubic yards of Class B concrete used in the construction.

FIGURE 18-CRACKS AS FOUND IN THE ROCKS

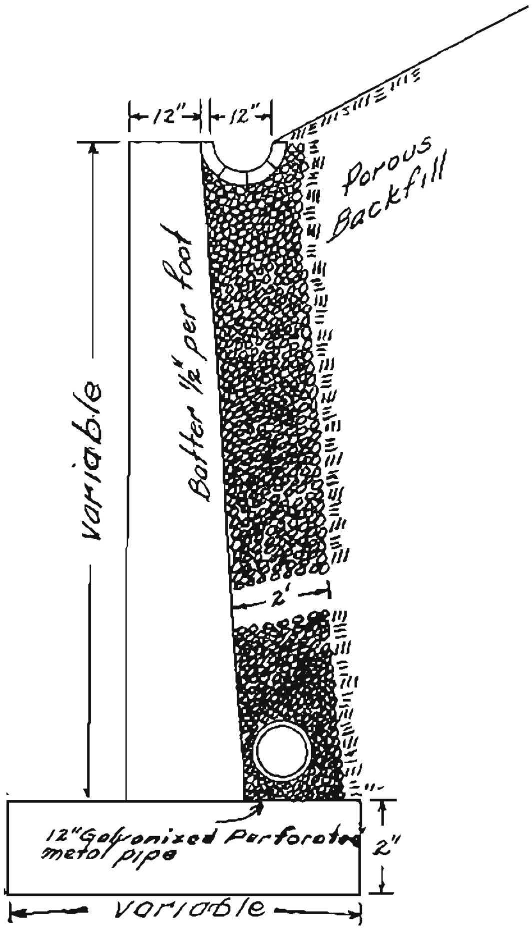


FIGURE 19-SECTION OF RETAINING WALL

## THE PORTLAND CEMENT CONCRETE PAVEMENT

This pavement is 50 feet in width, 10 inches thick on the edges, 8 inches thick in the center, and is reinforced with a heavy mat of steel. It is approximately 2.96 miles in length. White cement traffic markers are provided in the center 10 foot lane and the lip curb is also constructed of white cement to afford an additional traffic guide. A heavy chain link fence 4 feet high was constructed on the earth shoulders adjacent to the pavement to keep all pedestrian traffic from entering the highway. Sodding was not included in the contracts but it is the intention in the near future to sod all the earth from the pavement to the original ground.

## SODIUM VAPOR LIGHTS

The sodium vapor lighting system was installed throughout the project. This system is, without a doubt, the most efficient and practical method for highway lighting that could be attained today. The following is a description of the system and its operation:

Location: The lamp is suspended 25 feet above and 5 feet in from the outer edge of the slab, by means of a fluted hollow steel standard with a 12 foot arm projecting from the top. The standard is bolted to a circular concrete base. The lamps are spaced approximately 170 feet apart, staggered, or 340 feet from one lamp to another on the same side of the highway. The spacing is slightly closer around the bridges.

Efficiency: These are 10,000 lumen lamps, operating on a constant current of 6.6 amperes, each lamp using about 218 watts. The average city street lamp is of 4,000 lumen intensity, and uses about 400 watts. This gives a comparative efficiency of 4½ to 1 in favor of the sodium vapor lamp over the incandescent lamp.

Current Supply: The only current going up the pole is the 33 volts used by the individual lamp, which comes from a series I.L. transformer located in the base of each standard. This makes it possible to repair the lamp or any connection on the pole while the system is in operation, without danger to the lineman. Current is supplied to these transformers by a single line of Number Eight Parkway cable, from the central transformer at the sub-station. The sub-station transformers are two in number, capacity output of 2300 volts each, and are connected together in series. A double line of cable comes out of the transformers, one cable supplying the western half of the project, the other the eastern half. The current flows outward on both of these lines, to a neutral ground half way around the circuit. The transformers are the regulating type, and adjust the current output to the requirement of the line. There are 33 lamps on each half of the circuit, and by actual measurement the output of each transformer was found to average 1140 volts. Allowing 33 volts for each lamp, this leaves 51 volts or 336 watts loss on the line and through the I.L. transformer. The 6.6 amperes are constant for the whole system. The failure of any one lamp, or more than one lamp, does not affect the other lamps in the circuit, as the transformers are connected in series, and the main current goes straight through.

The lamps as spaced illuminate the roadway very clearly, even under the bridges, except at the grade separations. It should be possible to space the lamps so as to show the turnouts to the ramps a little more clearly. In localities where the smoke and fog are not as bad as in St. Louis a longer spacing should be possible. The spacing used on this project, under normal conditions, gives a greater abundance of light than is necessary. At the end of the arm on the standard where the luminaire is attached, there is at the present a screw connection that permits adjustment in a longitudinal line with the pavement. This connection should be altered to permit adjustment in a transverse line also. The makers of the standards advised that this was a simple change and would be taken care of on all future orders. The standards appear rather light, and there is a decided bend about 8 feet above the ground due to the weight of the luminaire and the extended arm. A more massive pole would be the solution to this problem.

## GENERAL CONSTRUCTION DATA

All structures are provided with conduits for electric lighting and all structural steel has received 3 coats of paint. The original contract on the first seven structures did not provide for painting, but rust streaks on the concrete under the structural steel became so unsightly that painting was added after the contract had been let. It is not the policy of the Missouri State Highway Commission to paint structural steel until it has been exposed to the elements for at least a few months.

The various parts of the project were awarded to the following contracting firms:

The first seven structures were constructed by the Fruin-Colnon Construction Company, of St. Louis. The grading over this portion was removed by the Ansbro-Maguire Company of St. Louis.

The Jefferson Drive and Kingshighway structures as well as the paving from the beginning of the project to the west side of the Kingshighway structure, was constructed by the Webb-Boone Paving Company, of St. Louis.

The paving, grading, and erection of the seven remaining structures was done by the Powers-Thompson Construction Company of Joliet, Illinois.

All labor was secured from the American Federation of Labor, with the consent of the Missouri State Employment Service.

It is proposed, as shown by the map on page A-1, to connect the west end of this project to Clayton Road by constructing an underpass under Skinker Road. The overhead leading from the east end of the project, over Vandeventer Avenue, connecting with the south side of the present viaduct on Chouteau Avenue is under contract to the Chase Construction Company and the Webb-Boone paving Company, both of St. Louis. The completion date is estimated to be June 1, 1938.

Some interesting facts established by the following table of construction data is as follows: The total cost of the project was $ 1,242,376 which provides payment for laying 121,015 square yards of Portland Cement Concrete pavement; constructing 13,253 cubic yards of concrete; 1,583,653 pounds of reinforcing steel; 756,210 pounds of structural steel and 476,079 cubic yards of excavation; as well as numerous other small items such as culverts and storm sewers.

The City of St. Louis furnished the right-of-way and the entire construction was financed by the National Recovery Act. Contracts were let and supervised by the Missouri State Highway Commission.

EXPRESS HIGHWAY CONSTRUCTION DATA

CITY OF ST. LOUIS

Project N.R.M. 475 $B_1$ Ansbro-Maguire Company.

| | Cost | Concrete | Steel Reinf. | Steel Struct. | Excavation |
|---|---|---|---|---|---|
| Grading, Drainage | $ 69,250.00 | 234.5 (B) | 26,086 | | 85,111 Roadway |
| Project N.R.M. 475 $B_2$ Fruin-Colnon Const. Company. | | | | | |
| Tamm Ave. | 32,795.00 (RE) | 578.9 (B) | 67,888 | | 2,344 |
| | | 89.9 (SHS) | | 94,520 | |
| Ped. O'Head at Tamm Ave. | 13,566.00 (RE) | 163.7 (B) | 14,010 | | 315 |
| | | 23.8 (SHS) | | 53,100 | |
| Hampton Ave. | 41,317.00 (RE) | 471.7 (B) | 99,620 | | 1,179 |
| | | 288.8 (SHS) | | 186,500 | |
| Ped. O'Head at the Arena. | 15,136.00 (RE) | 224.2 (B) | 18,240 | | 285 |
| | | 22.8 (SHS) | | 55,000 | |
| Ped. Underpass at Highlands. | 18,881.00 (RE) | 403.0 (B) | 37,370 | 500 | 1,040 |

## EXPRESS HIGHWAY CONSTRUCTION DATA (CONT'D.)

| | Cost | Concrete | Steel Reinf. | Steel Struct. | Excavation |
|---|---|---|---|---|---|
| Eques. Underpass at Mackland Ave. | $ 14,512.00 (RE) | 15.9 (A) | 32,650 | | 1,600 |
| | | 413.2 (B) | | 530 | |
| Ped. Underpass at Police Station. | 14,483.00 (RE) | 260.5 (B) | 24,970 | 500 | 1,000 |
| Project N.R.M. 475 $B_3$, $C_2$. Webb-Boone Paving Company. | | | | | |
| Surfacing | 169,307.00 | 70,703.0 (PCCP) | | | 4,651 |
| Grad. & Drainage. | 69,962.00 (R) | 500.0 (PCCP) | 2,206 | | 97,659 Rdwy. |
| | | 32.6 (B) | | | 2,021 Sewer |
| | | 6.2 (X) | | | |
| Jefferson Drive. | 25,043.00 (R) | 544.4 (B) | 76,270 | | 900 |
| | | 88.3 (SHS) | | 78,200 | |
| Kingshighway Underpass | 82,120.00 (R) | 9.8 (A) | 396,312 | | 1,592 |
| | | 2,261.6 (SHS) | | 16,800 | |

## EXPRESS HIGHWAY CONSTRUCTION DATA (CONT'D.)

| | Cost | Concrete | Steel Reinf. | Steel Struct. | Excavation |
|---|---|---|---|---|---|
| | Project N.R.H. 475 $C_3$, D, E. | Webb-Boone Paving Company. | | | |
| Surfacing | $ 56,763.00 | 21,179.0 (PCCP) | 119 | | 1,520 |
| | | 1.5 (B) | | | |
| Grad., Drainage, Surfacing. | 188,975.00 | 12,472.0 (PCCP) | 1,088 | | 128,946 Rdwy. |
| | | 61.6 (B) | | | 5,616 Sewer |
| Ped. O'Head at Deaf Inst. | 35,556.00 | 1,123.2 (B) | 100,400 | | 1,110 |
| | | 8.8 (SHS) | | 19,500 | |
| West Papin St. | 60,372.00 | 739.3 (B) | 61,460 | | 1,105 |
| | | 578.3 (B) | | 234,330 | |
| | | 145.7 (SHS) | 92,500 | | |
| Taylor Ave. | 25,765.00 | 9.8 (A) | 29,770 | | 680 |
| | | 285.6 (SHS) | 66,540 | | |
| | | 512.0 (B) | | | |

## EXPRESS HIGHWAY CONSTRUCTION DATA (CONT'D.)

| | Cost | Concrete | Steel Reinf. | Steel Struct. | Excavation |
|---|---|---|---|---|---|
| Newstead Ave. | $ 21,801.00 | 366.2 (B) | 15,490 | | 540 |
| | | 274.8 (SHS) | 65,710 | | |
| | | 10.0 (A) | | | |
| Grad.& Surfacing | 192,885.00 | 16,161.0 (PCCP) | 1,644 | | 116,987 Rdwy. |
| | | 1,003.0 (B) | | | 6,050 Sewer |
| Tower Grove Ave. | 36,693.00 | 10.0 (A) | 145,030 | | 945 |
| | | 336.0 (SHS) | | | |
| | | 854.8 (B) | | 5,330 | |
| Boyle Ave. | 30,570.00 | 10.0 (A) | 118,480 | | 755 |
| | | 280.9 (SHS) | | 4,310 | |
| | | 677.0 (B) | | | |

EXPRESS HIGHWAY CONSTRUCTION DATA (CONT'D.)

| | Cost | Concrete | Steel Reinf. | Steel Struct. | Excavation |
|---|---|---|---|---|---|
| Sarah Street. | $ 26,634.00 | 10.0 (A) | 89,800 | | 466 |
| | | 330.5 (SHS) | | 7,090 | |
| | | 393.3 (B) | | | |
| TOTALS | $1,242.376.00 | 121,015.0 (PCCP) 13,253.0 C.Y. | 1,583,653 | 756,210 | 476,079 |

Note :

(A) - Class A concrete masonry.

(B) - Class B concrete masonry.

(X) - Class X concrete masonry.

(SHS) - Special High Strength concrete masonry.

(PCCP) - Portland Cement Concrete Pavement.

(R) - Revised cost.

(RE) - Revised Estimate.

EXPRESS HIGHWAY CONSTRUCTION DATA (CONT'D.)

Class A concrete consists of 1 part cement, 2 parts fine aggregate and 3 parts coarse aggregate.

Class B concrete consists of 1 part cement, 2 parts fine aggregate and 4 parts coarse aggregate.

Class X concrete consists of 1 part cement, 2 parts fine aggregate and 3½ parts coarse aggregate.

These proportions are by loose dry volume. Through these ratios the weight proportioning mixes are calculated, using solid volumes.

Gradations of fine and coarse aggregate for Class A, B, and X concrete as required when tested with laboratory screens are as follows:

COARSE AGGREGATE

| | |
|---|---|
| Passing 1½ inch circular screens | 100% |
| Passing ¾ inch circular screens | 20-50% |
| Passing ¼ inch circular screens | 0-5% |

FINE AGGREGATE

| | |
|---|---|
| Passing ¼ inch circular screens | 95-100% |
| Passing No.20 mesh (0.833 m.m.) sieve | 35-70% |
| Passing No.50 mesh (0.295 m.m.) sieve | 5-20% |
| Passing No.100 mesh (0.147 m.m.) sieve | 0-5% |

These are the requirements of the aggregate as specified by the Missouri State Highway Commission on this project.

## CONCLUSION

The modern express highway is one which may be traveled without undue interruptions between designated points. In so far as this definition is concerned, St. Louis now has a highway that serves this purpose. The Express Highway through the City of St. Louis is, unfortunately, the result of Government and city planning. The Government limited the amount to be spent on the construction; while the city, in securing the right of way, chose the line of the least resistance.

There is only as much safety designed in highways today as the funds permit. The design of the Express Highway is far from that of a safe, high-speed highway. The curves east of Kingshighway are entirely too sharp. The short sight distance is lessened on these curves by the presence of the high retaining walls. Construction of highways where high retaining walls are necessary calls for as true an alignment as is possible. The fact that this is a continuous five lane traffic-way instead of the more desirable four lane dual highway will tend to cut down traffic-handling capacity in the future. All highways carrying more than 10,000 vehicles daily should be classed as dual highways. A physical separation of opposing traffic is a very strong safety measure.

Should there be a possibility that an express highway could be constructed, by the Government, as a commercial venture, then the Utopian in highway construction might be reached. Politics and finance are the chief shortcomings of modern highway construction.

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Reference No. Two - Actual costs on file with the Missouri State Highway Commission

Reference No. Three - Missouri State Highway Specifications

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